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HANDLING AND SHIPPING CITRUS FRUITS IN THE GULF STATES.

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INTRODUCTION.

The object of commercial fruit growing is profit. Even though a grower is successful in securing satisfactory yields of high-quality fruit, it does not necessarily mean that the business of fruit growing is a success financially. The primary object of commercial fruit growing can not be attained unless the crop can be disposed of profitably. Too many fail to realize that under modern conditions of handling, of long-distance shipment, and of marketing a perishable commodity such as citrus fruits, the growing of fruit is one thing and the marketing of it necessarily entirely another. Few growers possess the wide perspective or experience or can individually afford to obtain the information necessary to market their fruit to best advantage. The distribution and selling can be more successfully handled by thoroughly trained men and organizations devoting their entire time and effort to the disposal of such crops.

No attempt will here be made to discuss systems of marketing, or the marketing question in the usually accepted sense, but rather to point out some of the factors governing the merchantable condition

of fruit, particularly the relationship of harvesting and handling methods to losses from decay in transportation and at the markets.

Soundness and good keeping quality are of fundamental importance in the successful disposal of a perishable fruit crop. No system of marketing can procure for the grower the highest market price for his product unless it is delivered in sound condition, so that it will remain in good merchantable condition for a sufficient time to allow for proper distribution to the consumers. If the grower can not deliver his fruit at the market in good, sound, attractive condition, the money and labor invested in his orchard enterprise are largely, if not wholly, wasted.

CAUSES OF DECAY IN TRANSIT.

The losses from the decay of citrus fruits in transit and on the market are due primarily to fungi, which attack and cause decay or rotting of the fruit. Broadly and generally speaking, these fungi may be divided into two classes, parasitic and saprophytic. Parasitic fungi have the power to attack and cause decay in sound, uninjured fruit; saprophytic fungi usually can gain entrance and cause decay only through injuries, mechanical abrasions, or breaks in the skin or the cells composing it. It is safe to say that more than 95 per cent of the decay of citrus fruits occurring on arrival at the market and during the first ten days after arrival are due to attacks of fungi gaining entrance only through injuries of some kind. Blue mold is practically the only fungus of this type causing decay in oranges, grapefruit, lemons, and other citrus fruits in transportation and on the market. The losses from blue-mold decay, however, are oftentimes very serious and frequently the sole reason for low prices, demoralized markets, and losses instead of profits to the grower. There is not only the direct loss of fruit through decay, but the indirect losses due (1) to depreciation in prices for fruit actually sound, (2) to a reputation for poor keeping quality, and (3) to the proportionally high overhead expense of handling a perishable product which develops great waste and spoilage in transit and after arrival at the market.

The decay of citrus fruits from the Gulf States caused by parasitic fungi is usually not very serious, especially in transit and for the first week after arrival at the market. The most serious losses from this cause are due to attacks of fungi causing the type of decay commonly known as stem-end rot. Usually no stem-end decay is found on the arrival of the fruit in the market, nor does much of it develop under ordinary conditions during the first week after arrival. The losses from this decay are the most severe following a holding period of ten days or two weeks. This disease varies in severity with seasons and also with periods during any one shipping season. Climatic and tem-

perature conditions are very important factors governing the development of this disease both in the orchard and after the removal of the fruit from the tree, the losses being usually much heavier in the orchard than in transportation. If affected fruit could be successfully culled out at the time of picking and packing, stem-end rot would be a negligible factor in the marketing of the citrus crop, at least as far as the fruit actually shipped is concerned. The impossibility of grading out the affected fruit except such specimens as actually show decay from this cause makes it frequently an important factor in determining the keeping quality of the fruit on the market.

Diplodia rot is oftentimes associated with stem-end decay and during some seasons may be very serious. It closely resembles stem-end decay due to Phomopsis, and in the earlier stages is indistinguishable from it. For this reason it is also commonly referred to as stem-end rot. In Porto Rico and Cuba this Diplodia rot, next to blue mold, is one of the most serious causes of the decay of citrus fruits in transit and on the market.

Colletotrichum, or anthracnose, sometimes causes some decay in both oranges and grapefruit on the market, especially if these fruits are held for a long time under ordinary warehouse conditions or in cold-storage temperatures. In the handling of citrus fruits through the usual channels this disease is ordinarily not of importance.[1]

PREVENTION OF LOSSES DUE TO DECAY.

Obviously, the prevention of losses due to stem-end decay and diseases of a similar nature must depend on proper orchard, cultural, and sanitation practices, at least in so far as such practices can be depended upon to control or lessen the severity of attacks in the orchard. As stem-end rot develops very slowly in temperatures below 45° to 50° F., the liability to serious losses can be minimized by prompt cooling, the transporting of the fruit under low temperatures, and the holding of it on the market so far as practicable under low temperatures.

By far the most serious losses, as already pointed out, are due to blue mold, a fungus that gains entrance to and causes decay of citrus fruits only through injuries and breaks in the skin. Extensive investigations [2] and practical commercial experience have conclusively demonstrated that citrus fruits can be handled with sufficient care to prevent these injuries and to deliver the fruit on the market in sound condition, even under adverse climatic surroundings (fig. 1).

[1] Discussion and description of the diseases mentioned as sometimes being the cause of decay of citrus fruits in transit and after arrival at the market may be found in the following publications of the Florida Agricultural Experiment Station: Bulletin 53, "Some Citrus Troubles," by H. H. Hume; Bulletin 107, "Stem-End Rot of Citrus Fruits," by H. S. Fawcett; Bulletin 108, "Diseases of Citrus Fruits," by P. H. Rolfs and others; Bulletin 111, "Melanose and Stem-End Rot," by Floyd and Stevens.

[2] For a report upon these investigations, see U. S. Department of Agriculture Bulletin No. 63, entitled "Factors Governing the Successful Shipment of Oranges from Florida," 1914.

It has been conclusively shown that in so far as good, sound, merchantable condition is concerned the responsibility rests primarily with the grower and the shipper. The care exercised in preparing the fruit for market determines to the greatest degree its condition on arrival and its keeping quality while being held for distribution to the consumer. Keeping clearly in mind the importance of sound fruit on the market and the responsibility of growers and shippers for the condition of fruit on arrival and while being held on the market, one can not but be impressed with the fact that the grower himself largely determines the relative market price of his fruit. The matter

FIG. 1.—Oranges used in the Florida shipping experiments in 1911, showing the condition of the fruit on arrival at the market. This shipment was made during a period of very unfavorable climatic conditions. Blue-mold decay developed as follows (from left to right): Careful pick and pack, 4 per cent; commercial pick and careful pack, 35.6 per cent; commercial pick and pack, 68.1 per cent.

of proper handling is an economic problem of greatest importance, a problem of thorough organization and of human efficiency. The success or failure of the orchard enterprise often depends on this factor alone. Certainly no grower can hope to obtain the fullest measure of success without the strictest attention to methods of handling and harvesting in preparing his fruit for market.

WHAT CAREFUL HANDLING MEANS.

Many growers realize, at least to some extent, the importance of and necessity for careful handling, but oftentimes have no clear idea of what careful handling means or the seriousness of the slightest injury to the fruit. The elimination of losses due to blue-mold decay

is not a matter of attention to one or a few details of the handling problem, but of exercising the utmost care consistent with commercial work in all operations of picking, hauling, washing, drying, and packing, to prevent injuries, however slight. It necessitates thorough organization of labor and the most careful inspection of work, both in the field and at the packing house. With a view to more clearly emphasizing what constitutes careful handling practice, the various harvesting operations will be discussed separately. The recommendations and directions given are based not only on extensive investigational work, but on results of the most successful commercial practice in the practical handling of citrus fruits for shipment.

HARVESTING, PACKING, AND SHIPPING OPERATIONS.

The operations of harvesting and preparing citrus fruit for market may be divided into two parts—field handling and packing-house handling. The former includes all the operations of picking, hauling, and delivery of the fruit to the packing house; the latter the operations of cleaning, grading, sizing, packing, and loading. In picking citrus fruits for shipment it is necessary to sever the fruit from the trees by means of clippers (fig. 2). After the fruit is clipped it is placed in a picking bag or basket, from which it is emptied or transferred to the field box. Much of the fruit in most of the citrus sections, of Florida at least, can not be reached from the ground or from ordinary stepladders, and long ladders placed against the trees are used. The fruit in the field boxes into which it is emptied after being picked is hauled to the packing house on wagons equipped with springs. In the packing house, fruit that is affected with sooty mold, or otherwise in need of cleaning, is either run through dry brushers or through washing machines; thence on to drying racks or through driers to the grading belts. After being graded it is sorted by means of mechanical sizers, each size being run into separate bins for packing. The fruit is then wrapped and packed, according to diagrammatic arrangement, in boxes, and after the covers are nailed on it is ready for loading and shipment.

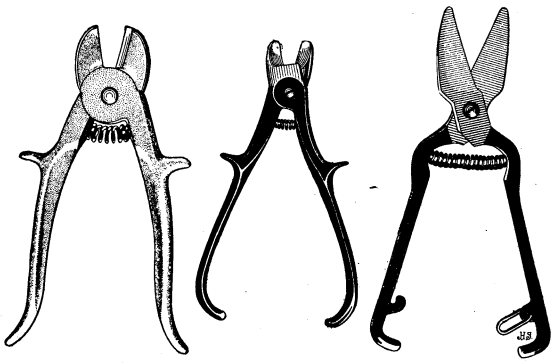

FIG. 2.—Three types of clippers used in picking citrus fruits.

FIELD HANDLING.

ORIGIN OF INJURIES.

One of the most common as well as most serious types of injuries made in picking is what is known as "clipper cutting." In severing the fruit from the branch the skin is often cut or punctured with the points of the clippers. Oftentimes, in clipping, the clippers leave a long sharp stem on the fruit, and while a long stem does not cause the decay or injury of the fruit to which it is attached, it is as serious as clipper cuts, if not more dangerous than they. A long, sharp, and jagged stem projecting from an orange may injure all the fruit with which it comes in contact in the picking bag, field box, brusher, washing machine, drying rack, packing bin, and the packed box. Long stems are among the most common as well as most serious imperfections in picking.

Considerable injury may also result from pulling fruit that can not be easily reached for clipping and from shaking the fruit so that it falls to the ground before placing it in the packing boxes. Injuries from thorn punctures frequently result either from high winds before the fruit is picked or through the carelessness of the pickers in handling the ladders or in transferring the fruit to the picking bag. Serious losses and decay result from injuries made by dropping instead of placing the fruit in the picking bag or basket, or, worse yet, by shooting it in; by cutting or scratching the fruit with the finger nails; by squeezing it against the picking ladder while in the picking sack; by carelessly emptying or pouring it into the field box; and by sand, gravel, splinters, protruding nails, etc., in the field boxes. In hauling, additional injury may result from putting too much fruit into the field box, from heaping it so that, in loading and stacking, the boxes rest on the fruit in the box below, and from the hauling of fruit on springless wagons over rough roads.

In the packing house the fruit is subject to injury in numerous ways in the course of the various operations of cleaning, drying, grading, sizing, and packing. The amount of injury inflicted in the packing house will depend both upon the care exercised by the workers and upon the arrangement, character, and state of repair of the packing-house machinery and equipment. The most common causes of injury are rough, careless handling by the workers; poor arrangement of machinery; undesirable types of washing machinery or machines carelessly operated; badly constructed drying racks or inefficient driers, steep gravity inclines or drops; scratches by finger nails in grading and packing; and lack of proper care in packing, nailing, and loading, either in handling fruits individually or in the packing box. The washing of fruit in dirty, infected water and slow or but partial drying serve to infect with the blue-mold fungus every

scratch or injury made either in the field or packing house and to provide ideal conditions for its germination and growth.

PICKING.

Unless the fruit is properly handled in the field at the time of picking, the care exercised in the handling of the fruit in the packing house and the provision of machinery and equipment especially designed to handle the fruit both economically and carefully are largely wasted. The injurious results of bad field handling can not be counteracted or atoned for by providing either the best equipment in the packing house or by exercising the greatest care in packing-house handling.

The amount of injury made in picking depends primarily on the picker and the equipment provided. In order to secure the desired results, the pickers must have a proper appreciation of and know what careful handling means and be supplied with the best tools and equipment obtainable. Given, however, the best of equipment, the care exercised by each picker in all the different operations of picking is the big determining factor. A careless workman will do poor work no matter what his equipment.

All pickers should wear gloves, to guard against finger-nail scratches, and the clippers should be sharp and properly set or adjusted, so as not to leave any ragged fragments in clipping. The points should be dull or rounded, in order to guard against cutting the skin of the fruit when bringing the clipper in position to sever the fruit from the branch. There are on the market several makes of clippers so constructed that while clipper cutting is not impossible, the chances for injury in this way are greatly minimized. In order to do the work properly, especially where the picker must reach some distance for the fruit, the stems should first be cut long and a second cut be made when the fruit is brought to a position where the picker can easily see what he is doing. This method of clipping removes any and all excuse for clipper cutting or the leaving of long stems. While this double cut may take a little longer, practice soon enables a picker to accomplish as much in this way as the other, if quality of work is given equal consideration with quantity.

After the fruit is properly clipped, that is, after the stem is cut off clean and close to the fruit in such a way as not to leave a part protruding, to cut or injure other fruits, it should be placed in the picking bag by hand, not dropped or thrown in, as is too frequently done. The dropping or throwing of the fruit into the picking bag or basket and into the field box is one of the most common and serious causes of injury and resultant decay in transit.

A heavy canvas bag carried from the shoulder by means of a strap and holding not more than half a field box is to be preferred as a picking

receptacle. This bag should be partly closed at the top, making it necessary to place the fruit in the bag by hand, and the bottom should be open but folded up on the side and fastened by hooks or ropes near the top, so as to make a sack or bag. In transferring the fruit to the field box, the whole bag is lowered into the box and the fastening and fold loosened; after which the bag is drawn upward and away, allowing the fruit to roll gently and easily into the field box (fig. 3). This type of bag is preferable to the bushel basket or wicker basket frequently used and to other picking receptacles from which the fruit has to be poured or emptied through the same opening used in picking. With the wicker basket there is a tendency to shoot or drop the fruit into it in picking and to pour the fruit into the field box rather roughly or carelessly in emptying. Good work undoubtedly can be done even with a basket, but it offers too many inducements for carelessness. The things to guard against in using the picking bag are the danger of bruising the fruit between the ladder and the picker's body and the possibility of thorn punctures through the canvas. If good heavy canvas is used, there is not much risk of the puncturing. Great care should be exercised in handling and setting the ladders, in order to avoid bruising the fruit against the ladder or limbs or scratching it on branches or thorns. Where step-ladders can be used, they are preferable, but most of the older orange and grapefruit trees in Florida are too high and large for this type of ladder.

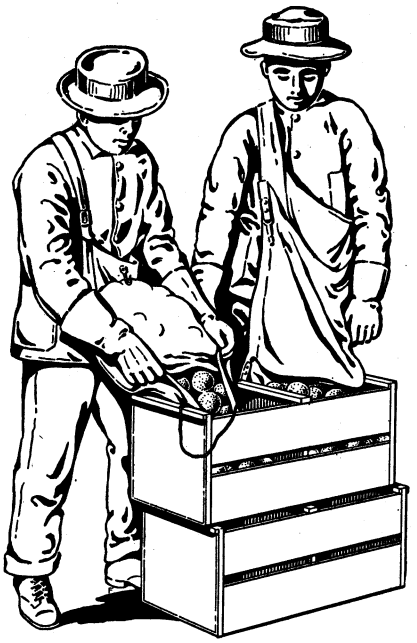

FIG. 3.—Transferring oranges from a picking bag to a field box.

USE OF THE FIELD BOX.

The field box in common use in most of the citrus sections of Florida holds approximately one packed box of fruit. It is usually about 28 inches long, 12 inches wide, 13 inches deep, and may or may not have a central upright partition (fig. 3). A common source of injury in field and packing-house handling is the poor condition of the field box. Every box sent into the orchard or grove should be thoroughly inspected, kept in good repair, and free from protruding nails, splinters, gravel, and twigs. A box entirely boarded over on the bottom is pref-

erable, as this prevents injury by stems of weeds and other objects that might otherwise extend into the box and injure the fruit. The boxes should not be filled or heaped to such an extent that any fruit will rise above the end pieces, as where it does the boxes when stacked will rest on the fruit instead of on the ends of the boxes themselves.

This type of field box came into general use through the practice of buying large quantities of fruit on the trees at a fixed price per box. Originally this price was intended to be per packed box, but since it is more convenient to keep the record of the fruit as it leaves the grove, this type of field box, which holds enough fruit to allow culling and still give the buyer a packed box of oranges, was developed. This field box, from the standpoint of careful handling, is not an ideal one by any means. It is too heavy to be handled by one man as carefully as it should be in loading and unloading. In the handling of boxes of this weight and size, they are frequently dropped or set down violently either on the wagon or when unloading in the packing house. A box made of lighter material and holding somewhat less fruit could be handled by one man with much greater ease and care. It is also a question whether a smaller, lighter box would not withstand to a greater degree the "bucking," as it is usually termed, when unloading the empty boxes in the field. The breakage and bad repair of field boxes are due largely to rough, careless handling in disposing of them after emptying or in distributing them in the orchard, where they are often thrown violently and carelessly from the wagon into piles on the ground. Due care should be used in handling the boxes when filled, in order not to injure the fruit in them, but equal care is required in the handling of the field equipment when empty, in order to guard against breakage, splintering, etc.

HAULING.

The wagons on which the fruit is hauled should always be provided with good springs, and no fruit, under any circumstances, should be hauled on springless wagons, no matter how good the roads may be. The driver should be provided with a special seat, leaving him no excuse for riding on top of the load or on the fruit itself. The field boxes should be properly loaded and stacked, and if necessary the load should be thoroughly roped to prevent the shifting of the boxes, and the utmost care should be used both in loading and unloading to guard against unnecessary jolting or rough handling. Where boxes of the heavier types are used, it is not an infrequent occurrence to see them set down or dropped with such force as to cause considerable fruit to bound out on the floor of the packing house. Care in handling the fruit both in the field and packing house is oftentimes largely nullified by careless, rough handling in hauling and unloading.

SUPERVISION AND PAYMENT OF PICKING CREWS.

Where the picking is done by picking crews hired by the grower, shipper, or marketing organization, a good reliable foreman should be secured, and it should be the duty of this foreman to see that all pickers do their work carefully and properly, that the clippers are in good condition, that the picking boxes are in good repair, and generally to supervise the quality of work in field handling. In order that he may know just what kind of work his pickers are doing, he should make frequent inspections of each man's work, ascertaining by actual count his percentage of clipper cuts, long stems, and other injuries and imperfections. These duties, if properly and conscientiously performed, will require all his time, and in most cases he should not be required to do any picking. The payment of pickers by the day, instead of by the box, is preferable from the standpoint of securing careful and proper work, as box or piece labor usually puts a premium on quantity primarily. Careful inspection of the character of work secured under the two systems of labor payment has conclusively shown that the pickers working by the day average on the whole much better work. On the other hand, good work can be secured with either the box-payment or day-payment plan if the labor is properly supervised. The character of work done by a picking crew depends on the foreman, and the responsibility for the field handling rests primarily with him. An efficient foreman can secure careful work under either system of payment, though much more easily and surely where the pickers are paid by the day.

RELATION OF FIELD HANDLING TO COOPERATIVE AND ORGANIZED MARKETING.

The importance of proper field handling is fully recognized by most cooperative and marketing organizations which attend to the preparation of the fruit for market as well as the selling and distribution end of the business. The fruit brought into an association packing house during any one day usually comes from a great many growers in the surrounding territory, and after it has been properly weighed and graded it loses its identity as far as the grower is concerned. This means that each car shipped may contain fruit from a great many growers. Careful investigation of the character of work performed by different picking crews, especially where the picking is done by the growers or under their direction, has shown that there is a great difference in the kind of work being done. One grower may pick his fruit with the greatest possible care, while his neighbor may do exactly the opposite. The fruit from both growers may be shipped in the same car, the carefully handled fruit arriving in sound condition, the fruit carelessly handled developing much decay in transit and at the market. The poor work of one grower in picking in this way nullifies to a considerable extent the good work of the other

The different associations have therefore found it to their advantage, and in most cases necessary, to take over and assume full responsibility for the field handling of their growers, through employing trained crews properly supervised to do the picking. This insures uniformity in the handling of the fruit of all growers throughout all the harvesting operations and serves to place all growers on the same and a just basis. Practical experience and careful investigation of the facts in the matter have conclusively shown this to be the most satisfactory way of managing the field end in an organization handling citrus fruits from several growers, especially if the fruit from the different growers is pooled or shipped in the same car. The merchantable condition of the fruit depends primarily upon the kind of handling given it in preparing it for market. Commercial

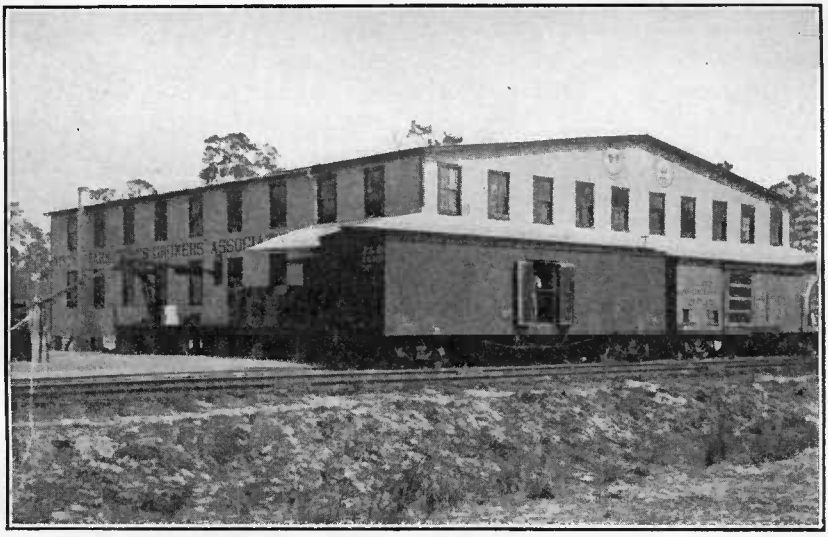

FIG. 4.—A two-story building with excellent facilities for packing and shipping citrus fruits.

experience has shown that it is almost impossible to secure uniformly good results where the picking and field handling are left to the individual grower. Even if the grower realizes the necessity for careful handling, he does not always know just what careful handling means or the seriousness of injuries in handling, nor can he employ the trained labor or supervise it to the extent possible where the crews are employed by an association or organization throughout the harvesting season.

PACKING-HOUSE HANDLING.

Wherever possible, it is desirable to locate the packing house near the railroad, in order that the fruit after it is packed can be loaded directly into the car from a loading platform without further hauling or loading and unloading from a wagon (fig. 4). No attempt will be

made to give definite plans for a packing house, as the size, equipment, arrangement, etc., must necessarily depend on the quantity and character of fruit to be handled. In general, it may be said that the best packing house is not necessarily the one that has the most machinery in it or that costs the most. The size of a packing house and the character of its equipment will depend largely upon the amount of fruit to be handled and whether the fruit has to be washed or cleaned. In equipping and arranging the machinery the one thing that should be kept in mind more than any other is simplicity. The fruit should be kept on one level as much as possible, from the hopper or washing machine to the packing bins (fig. 5). Gravity runs, drops,

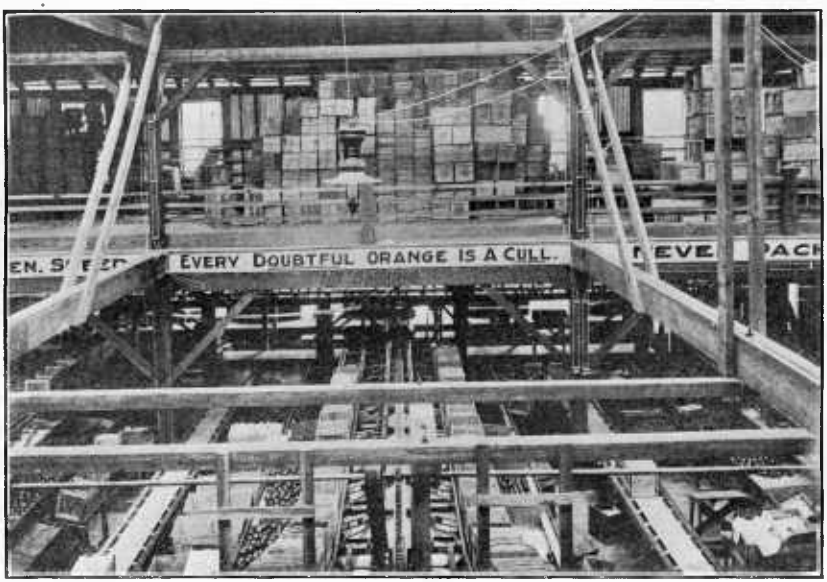

FIG. 5.—Interior of a well-arranged packing house. Note the grading belts in the rear in the well-lighted portion of the house, the carrier, or chute, for empty boxes above the packing bins, the stands for the packing boxes, and the carrier for the packed fruit.

and sharp turns or angles should be avoided as far as possible. At no point in the handling operations should the fruit actually be dropped more than 3 or 4 inches; in fact, practically no drop is necessary, if the house is properly arranged, with the exception of the drop from the sizers into the packing bins, and 3 inches should be the maximum even here. A well-lighted packing house is essential to proper grading and good work generally. The importance of good sanitation and of keeping the house absolutely clean and free from rubbish and decaying fruit can not be overestimated. Decayed fruit in or near the packing house is a prolific source of blue-mold infection and a sure indication of inefficient or indifferent management.

Sufficient room should be provided inside the house for stacking the fruit hauled in from the orchard and for packed fruit awaiting loading. Space ordinarily is provided in the second story for box shooks and the making of them into boxes. Gravity runways or chutes can easily be provided for carrying the made-up boxes down to the packing room, where they can be easily reached by the packers.

USE OF THE HOPPER.

Where washing is not necessary, the fruit is usually first emptied into a hopper, after which it passes either over dry brushes or directly to the grading belts. A hopper holding not more than two boxes of fruit is desirable. It should be well padded and have only sufficient slant to provide for the easy movement of the fruit. In emptying from the field box to the hopper, the greatest care should be exercised to transfer the fruit without dropping it or throwing it any distance. This operation can be accomplished with little or no injury either by holding the fruit back with the arm or hands in emptying or by using a canvas cloth to hold the fruit back, so as to allow it to roll out easily and gently from the box into the hopper.

Considerable injury is often caused by carelessly emptying or virtually throwing the fruit from the field box into the hopper and by the use of hoppers that are altogether too large. Not only should the utmost care be exercised in placing the fruit in the hopper, but the hopper itself should be kept absolutely free from twigs, gravel, sharp edges, or protruding nails that would injure the fruit placed in it. Formerly very large hoppers were used, frequently holding a wagonload or more of fruit, the grading being done at the lower end of the hopper before the fruit passed to the sizing machine. This type of equipment, however, has been almost entirely replaced by the smaller hopper and canvas or roller conveyer belts for grading.

WASHING AND CLEANING.

In many sections of the Gulf coast region where citrus fruits are grown, the washing or cleaning of the fruit prior to packing is absolutely necessary, in order to remove the sooty-mold fungus which follows the attacks of the white fly and other insects. Washing will continue to be one of the necessary handling operations until the growers take the necessary steps to control the white fly in citrus groves and to grow clean, bright fruit. If it were possible to do away with washing entirely, a great deal of decay occurring in citrus fruits in transit and while being held on the market could be prevented. There is little or no question that if the losses resulting from the washing and drying operations could be saved, the expense of time and money necessary to grow clean fruit would be more than compensated for.[1]

[1] For information regarding the control of the white fly and other insects which attack citrus fruits, write to the Bureau of Entomology, Department of Agriculture, Washington, D. C. The agricultural experiment stations located in the States where citrus fruits are grown will furnish bulletins and information in reference to the control of insects.

However, if the fruit is in such condition that it has to be washed, it is essential that every precaution be taken to perform this operation in such a way as to inflict as little injury as possible on the fruit as it passes through the washing machine. Washing and drying are the most complicated processes through which the fruit is put in a packing house, and these combined operations involve a great deal of extra handling, which furnishes additional opportunities for mechanical injuries. Extensive investigations have shown that the decay in packed fruit is largely due to injuries received or aggravated during the operations of washing and drying, and the bad effects following washing are due not so much to actual injuries made in passing fruit through the machine as to the inoculation of injured and bruised spots with fungous spores through the agency of dirty and infected water. Injuries made in the grove or in other operations of handling, or injuries made as the fruit passes through the machinery, are aggravated by the addition of moisture, especially when the water is not clean.

The three main causes of decay following the washing and drying operations are (1) dirty and infected water in the soaking tank, (2) poorly constructed or operated washing machinery, and (3) the slow or but partial drying of the fruit under unfavorable climatic conditions. The first can largely be obviated by the proper handling of the fruit in the field and in hauling, so as to bring it to the washer in sound, uninjured condition, and by frequently changing the water in the washing tank, or by the elimination of the washing tank entirely where possible and the substitution of a spray before the fruit reaches the washing machine, in addition to the spraying of it as it goes through or over the brushes. Where the fruit is badly covered with sooty mold, a soaking tank is almost a necessity. Where used, the water should be changed frequently, at least two or three times a day. No definite or particular make of washing machine can be recommended, but, in general, the following points and requirements should be kept in mind:

The fruit should be constantly in plain sight while going through the washing machine; there should be no pressure or weight on top of it or any considerable pressure laterally, the cleaning being done entirely by the weight of the fruit itself in passing over the brushes or other cleaning devices (fig. 6).

There should be little or no opportunity for the fruits to tumble over or rub against one another.

It is essential that the machine be kept thoroughly clean and free from twigs, protruding nails, or anything of that sort that would injure fruit going through it.

After having selected a machine of the type fulfilling as nearly as possible these requirements, the amount of injury incurred in washing will depend largely upon its operation and upkeep. Frequent inspection of the machine is desirable, in order that the worn-out

brushes may be replaced with new ones. Without such inspection from time to time, some little thing may get out of order that will cause an enormous amount of injury and consequent decay of fruit.

DRYING.

After the fruit has been washed, it may be run through dry brushes or directly to a drier or to drying racks. Of late, most of the packing houses, at least the larger ones, have substituted artificial driers for the drying racks so common a few years ago. A drying rack, if properly handled and placed, may from some standpoints be satisfactory.

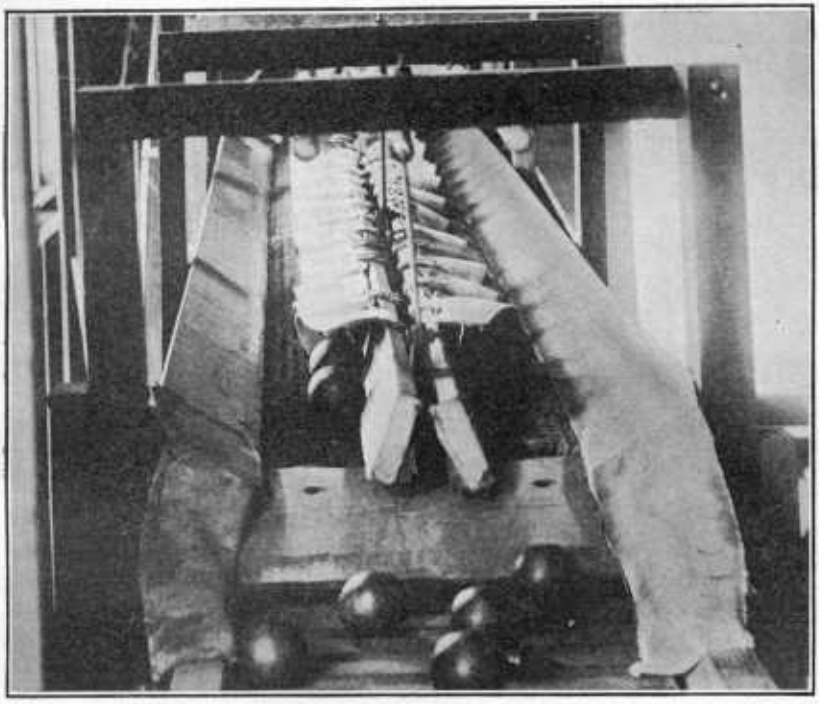

FIG. 6.—A type of washer in common use for cleaning citrus fruits.

If placed outside of the packing house, drying can be done only during favorable weather. To place the drying rack inside the house means the elevation of the fruit a considerable distance and the rolling of this fruit down rather steep gravity runs. It is almost impossible to keep such devices free from splinters and to handle the fruit on them without inflicting more or less injury.

The artificial driers now in use are open to somewhat the same objection, in that they do not do satisfactory work under the most unfavorable climatic conditions or during prolonged periods of rainy weather. Great improvements in driers, however, are constantly

being made, and, where properly handled, more satisfactory work can be obtained with artificial driers than with the ordinary drying racks. These driers are usually made in the form of a long box, through which the fruit is carried on roller conveyers one or more times. The drying is accomplished by forcing a considerable volume of air through this box either from one end or, more commonly, from several points along the sides or top or through the bottom of the drier, in order to distribute the air more evenly. Under dry, sunshiny conditions, the ordinary air usually serves the purpose, but during cloudy and rainy weather it is necessary to heat the air somewhat, in order to accomplish thorough drying during the time the fruit is passing through the drier. Under very unfavorable climatic conditions, such as occur frequently during the harvesting and picking season, it is exceedingly difficult to do thorough drying, even with warm or heated air.

It is of the greatest importance that the fruit be thoroughly and quickly dried. The blue-mold spores require moisture for germination, and if the fruit is left for any length of time in a moist condition, or if packed while still wet, ideal conditions for the germination of these spores are provided, and if any of the oranges are injured decay is certain to result.

GRADING.

The fruit is usually run on to grading belts directly from the drier. These grading belts may be either of canvas or in the form of roller conveyers which keep turning the fruit as it passes before the graders. In order to do grading properly, it is necessary to have good light. This point can hardly be overemphasized, as one of the most common mistakes in building a packing house is to provide insufficient light for grading. Generally speaking, there are no uniform rules for grading oranges and grapefruit in Florida, and, as a rule, only two classes are made—brights and russets. In the bright class, or first grade, is placed all bright, well-colored fruit, while the second grade, or russet, is usually composed of fruit more or less affected by the work of the rust mite, by melanose, or by other skin blemishes. The finest of the brights may be packed as "Fancy" or some of the brightest russets may be labeled "Golden." Sometimes, however, similar grades of fruit from different packing houses may be sold under entirely different grade names. The tendency now is to establish more uniform regulations regarding grading, to market certain grades under established brands, and never to ship under such brands any but fruit coming up to the specified grade.

The grading of the fruit, however, is entirely without reference to the size of the fruit. Whatever grades are made or established, it is of the greatest importance that the grading rules be strictly adhered to and that the first grade contain no fruit except such as is clean and

free from blemish and which comes up to the first-grade requirements in every way. If there exists any doubt regarding the grade in which the fruit is to be placed, it is preferable to place it in a lower rather than in a higher grade. The uniformity of grading and the dependability of grades do much to establish the reputation of particular brands on the market. Good grading goes hand in hand with good, careful work in the other operations of harvesting and handling.

SIZING.

In equipping a packing house, separate sizers are usually provided for each grade and one bin for each size of a grade. After the fruit is properly graded it continues on either canvas or roller conveyer belts to the mechanical sizers and thence into the packing bins. The sizers should be selected primarily with reference to the accuracy of sizing and the ease with which the fruit is handled, and great care should be exercised in constructing and arranging the bins to guard both against long drops from the sizer to the bin and the piling up of fruit in the portion of the bin next to the sizer to such an extent as to interfere with the proper sizing of the fruit. Accuracy in sizing is of great importance in determining the appearance of the pack and the price paid for the fruit at the market end. Good fruit, uniformly well graded and sized and in sound condition, soon gains a reputation for soundness, quality, and dependability that commands for it the highest market price throughout the season.

PACKING.

Good packing involves both science and art. Next to soundness and keeping quality, the appearance and attractiveness of the pack are the greatest factors in determining the market price of fruit, and it is therefore of the greatest importance that this part of the handling operations be carefully and efficiently supervised. During the last few years attempts have been made to put up what are called bulge or high packs, as against the former practice of putting up a pack that was practically flat and even with the ends of the box. While a high pack is desirable, at least from a marketing standpoint, there are certain features and methods of procuring such a pack that should be kept clearly in mind. Oftentimes the fruit is packed loosely in the box, the last layer protruding considerably above both ends and sides of the packing box, the bulge being obtained by squeezing the fruit down at the ends when nailing on the cover. However, even though the fruit may have the desired appearance at the time it is loaded into the car, it settles in transit and when it arrives on the market the box is slack and has a very poor appearance. The squeezing of the fruit down into the ends of the box by means of the cover also results in a great deal of injury and decay in transit.

The best pack for all purposes is a firm, moderately high one, all of the fruit being packed in tightly from bottom to top. After some experience the packer will have no difficulty in securing the desired bulge with this firm pack. If the fruit throughout is firmly and tightly packed and it remains in sound condition, the pack will not become slack in transit, as is the case where the fruit is rather loosely packed in the bottom of the box.

Considerable injury is done by dragging the oranges around in the bins and tossing the off sizes into neighboring bins. Every packer should wear a glove, at least on the hand which picks up the fruit, so as to avoid finger-nail scratching. The packing bin should be thoroughly padded and kept free from dry twigs and other trash, and the drop from the sizer to the bin should be the shortest possible.

In the packing of citrus fruits, each fruit is wrapped in thin wrapping paper, different sizes of paper being used in accordance with the size of the fruit being packed. In wrapping citrus fruits preparatory to packing, the stem should always be placed in the twist of the paper and the fruit should be tightly wrapped in such a manner that the paper will not fall off from the fruit when taken out of the box, without being removed by hand. Poor wrapping and inattention to placing the stem of the fruit in the twist are but another sign of careless work and inefficient management. The name of the grower, association, or marketing organization, with its brand or trade mark, is very frequently printed on the wrapping paper. Some houses pack all but the bottom and top layers in plain papers, using the paper with the brand printed on it only for the top and bottom layers. It would seem, however, to be more consistent and preferable to use the printed paper throughout the package, if at all. The usual sizes of round oranges run from 96 to 288, the more common sizes being 126, 150, 176, 200, and 216 to the box. Figure 7 gives a diagrammatic representation of the method of placing the fruits of various sizes in the packing box. The arrangement as shown in the box end to the left is that for the first or the bottom layer; the one on the right is the second layer, which is placed on top of the first. The third layer is the same as the first, and the fourth the same as the second, and so on.

Figure 8 gives a diagrammatic illustration of the method of packing grapefruit of the different sizes, with the arrangement of fruits in each layer, the number of layers in each end, and the approximate diameters as ordinarily used. Certain sizes are oftentimes packed differently from the arrangement shown in the diagram, the packs here illustrated being the ones more commonly used and preferred at the present time. The sizes and number of grapefruit in a box may vary from 18 to 96, the most common sizes usually running 46, 54, 64, and 80 to the box. The diameters given both for oranges and grapefruit

are average diameters only, these being varied somewhat in accordance with the shape of the fruit and the tightness of pack desired. The boxes commonly used for either oranges or grapefruit contain a space of almost exactly 2 cubic feet, the outside measurements approximating 12½ by 12½ by 27 inches.

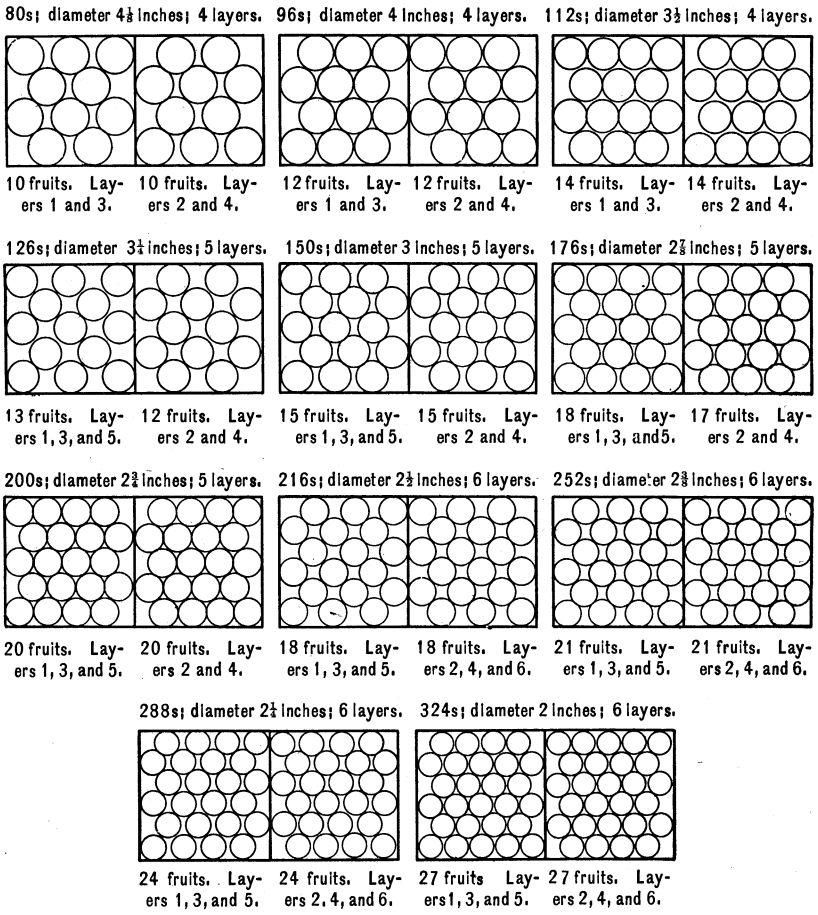

FIG. 7.—Diagrams illustrating the arrangement and methods of packing sweet or round oranges of different sizes in layers in standard boxes. The number of fruits and the approximate diameter of each fruit in the box and the number of layers in each end are given above each diagram. The number of fruits in each layer is shown below the diagram.

SIZING AND PACKING MANDARIN ORANGES.

Tangerines, mandarins, and King and Satsuma oranges are usually packed in half boxes, or "straps." The sizes for these fruits usually run from 48 to 216, the most common sizes being intermediate between these two. Figure 9 illustrates the arrangement of various sizes of these fruits in packing. There is some variation in different sections, of course, in the method of packing these sizes, the arrange-

ments illustrated being the ones in most common use. In shipping, two of these boxes are usually strapped together and loaded the same as one box of round oranges or grapefruit.

In the Mobile section of Alabama and other districts of the Gulf coast where Satsuma oranges are grown on a considerable scale, more attention is being given to the development of distinctive Satsuma packs. The methods of packing Satsuma oranges in the sections outside of Florida are very similar to those illustrated for mandarin oranges. Practically the same box is used, one measuring approximately 12 by 6 by 24 inches inside measurement and having a capacity

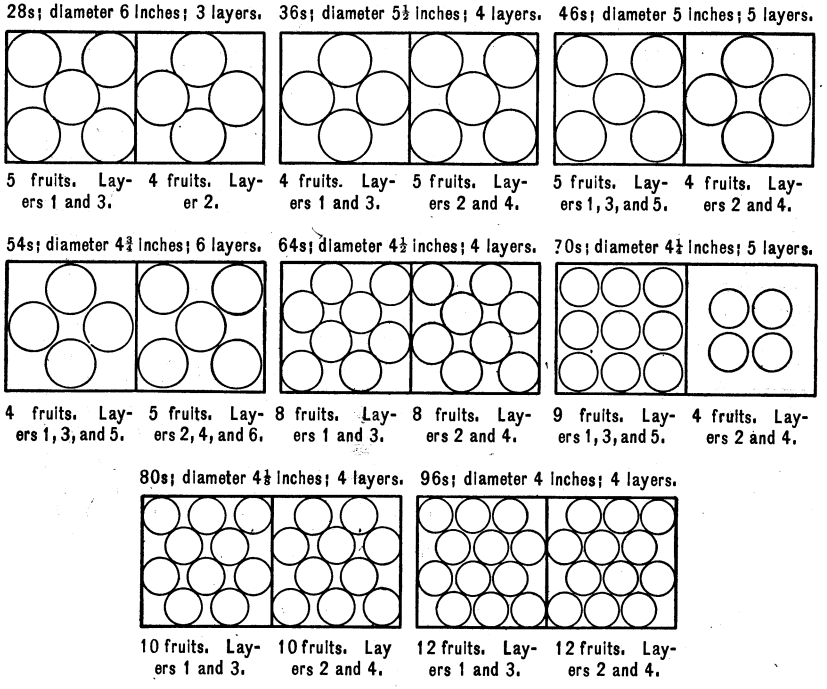

FIG. 8.—Diagrams illustrating the arrangement and methods of packing grapefruit of different sizes in layers in standard boxes. The number of fruits and the approximate diameter of each fruit in the box and the number of layers in each end are given above each diagram. The number of fruits in each layer is shown below the diagram.

of 1 cubic foot. The arrangement of the packs is essentially the same, the principal difference being that the sizes generally run about one-quarter inch larger than those given in figure 9. This necessitates somewhat tighter packing and tends to give the pack a considerable bulge. In addition to the packs illustrated in figure 9, packs with 240 and 288 fruits to the box are used to some extent. The fruits in the 240 pack have a diameter of 2¼ inches and are packed 4 and 4 in six rows of five layers. In the 288 pack the oranges having a diameter of approximately 2⅛ inches are packed 4 and 4 in six rows of six layers.

NAILING.

Many modern packing houses, especially the larger ones, have installed roller conveyers or some other conveyer device for carrying the packed box from the packer to the nailing bench. Where these are provided, all that the packer has to do is to remove the box from the inclined bench holding the packed box to the conveyer alongside.

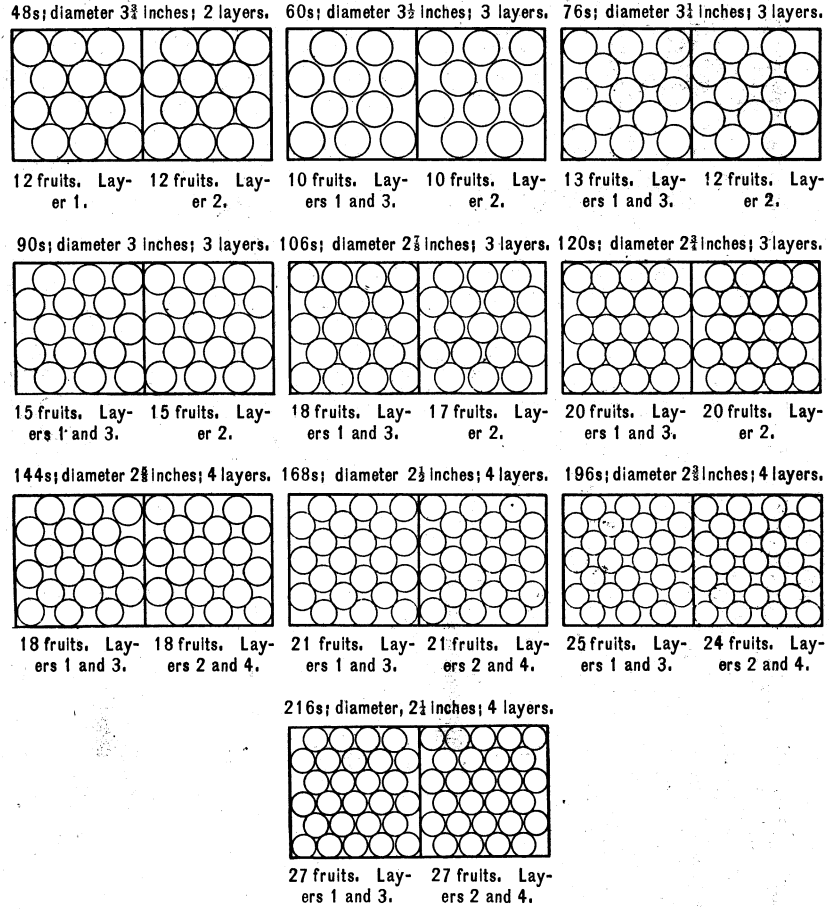

FIG. 9.—Diagrams illustrating the arrangement and methods of packing mandarins, tangarines, and King and Satsuma oranges in layers in standard half-size boxes or straps. The number of fruits and the approximate diameter of each fruit in the box and the number of layers in each end are given above each diagram. The number of fruits in each layer is shown below the diagram.

The cover may be nailed on, either with or without the use of a press (fig. 10). In either case great care should be taken in putting on the cover to prevent injury to the top layer as the fruit is necessarily pressed down at the ends and the sides. If the center of the box and the inside edges of the ends, as well as the sides of the box, are beveled, the liability to injury in putting on the cover is very much decreased.

Formerly all the boxes were bound with three wooden straps, one around each end and one around the middle. While these still are being used to a considerable extent, metal straps have come into quite general use. These straps are usually nailed on three sides when the box is made up and looped over the top and firmly nailed

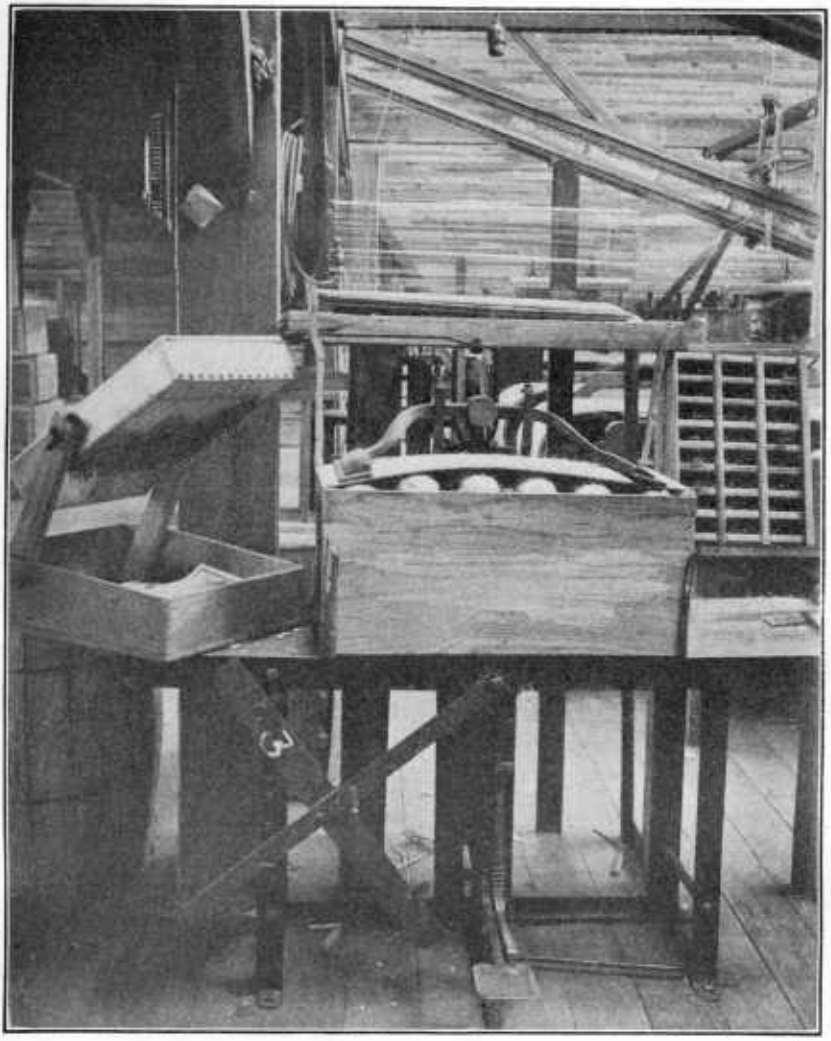

FIG. 10.—A box press used for putting on the cover of a packed box of citrus fruits.

in place after the cover has been put on. In some of the packing houses the end straps are omitted entirely.

LOADING.

It is of great importance that the boxes be so loaded in the car that there will be no shifting or breakage in transit. The fruit is often

loaded either on end or on the side, without cleating or bracing. A safer and better method, however, is to load all boxes on end two tiers high throughout the car. The most common loads are 300, 330, and 360 boxes. The 300 load is secured by loading five rows across, 30 boxes long and 2 boxes high. The 360 load is secured by loading six rows across, 30 boxes long and 2 boxes high. In loading 330 boxes in a car the bottom tier is the same as with 360, while in the upper tier some of the boxes are usually laid on their sides through the middle of the car. Each row should have two substantial car strips nailed across the ends of the boxes, one strip being shoved tightly up against the car wall on one side, while the other strip on the same row of boxes should be placed tight against the opposite car wall. If this method is used, it will prevent the shifting of the load in any direction.

CURING.

In some citrus sections of the Gulf coast region the curing or holding of oranges and grapefruit for a few days prior to packing and shipping is still practiced. The principal arguments in favor of curing have been that the holding of the fruit for a considerable time in the packing house will permit the throwing out of fruit predisposed to or showing decay and the putting up of a tighter, firmer, and more attractive pack, owing to the greater pliability of the fruit. The arguments do not seem to be well founded and the practice itself seems to be not justified. Both investigational and commercial results have clearly demonstrated that because of the slow development and growth of the blue-mold fungus the decay ordinarily does not develop sufficiently during the curing period to be distinguished and thrown out by the graders. Moreover, delayed fruit, mechanically injured almost without exception, shows considerably more decay both on and after arrival at the market than similar fruit packed and shipped immediately. As regards the claim that wilting or curing is necessary in order to put up a tight, firm pack without injury, practical experience has demonstrated that a pack fully as firm and as attractive in appearance can be put up the same day the fruit is picked from the tree. The holding of the fruit in the packing house during a curing period permits added opportunity for infection and affords ideal conditions for the development of blue-mold decay in transit and at the market. In view of the increased decay that is likely to result from curing and the entire practicability of putting up without injury a tight, firm pack without wilting or curing, all citrus fruits except lemons and perhaps limes should be shipped as soon as possible after removal from the tree.

METHODS OF SHIPMENT.

Citrus fruits from the Gulf States may be transported by several routes and under as many methods of shipment. The great bulk

of the fruit from Florida and the other older citrus sections in the Gulf States is shipped by rail in full carload lots under either ventilation or refrigeration. Small consignments are sometimes forwarded either by express or by freight to near-by and distant markets or to assembling points for reshipment either by rail or by water. Considerable fruit is shipped by water from Jacksonville, Savannah, and other Gulf coast ports and from points on the Mississippi River in Louisiana.

REFRIGERATION.

Up to within a few years, practically none of the citrus-fruit shipments from Florida were carried under refrigeration. The prevailing opinion has been that citrus fruits do not need refrigeration, especially as most of the crop is moved during the winter months when the outdoor temperatures in all but the Gulf States are low; so low, in fact, that the problem has been to protect the fruit against freezing. In order to avoid, as far as possible, damage by freezing, citrus fruits are now almost universally transported in refrigerator cars whether under ventilation or refrigeration.

During the warmer periods of the shipping season and during periods when decay is unusually heavy, a considerable proportion of the shipments are now iced. The shippers generally claim that shipments under refrigeration, especially during such periods as are above mentioned, arrive in sufficiently better condition to more than offset the added cost. There is little or no question regarding the value of refrigeration for citrus fruits under certain conditions; nevertheless, there are certain points that should be kept clearly in mind.

The investigations of the Department of Agriculture have conclusively demonstrated that oranges and other citrus fruits can be transported to market under ventilation with the minimum amount of decay, even during periods of warm, humid weather, provided sufficient care is exercised to preserve the skin of the fruit in a sound, unbroken condition. The use of refrigeration in transit can not be depended upon to offset the effects of rough or careless handling. The low temperatures secured by icing may arrest or retard the development of decay fungi only to have decay develop rapidly after unloading or exposure to warmer temperatures. Thus, while the fruit may arrive in practically sound condition, it will gain a reputation for poor market-holding quality if it has been injured by careless handling. It is fully as important in the long run that fruit possess good keeping quality on the market as that it arrive in sound condition.

It should also be kept clearly in mind that the cooling of the fruit in a refrigerator car even where the ice bunkers are full is exceedingly slow. Extensive investigations of temperatures of citrus fruits in transit under various methods of shipment have shown that it takes

five to seven days for the ice in a refrigerator car to bring the temperature of all of the fruit in the car down to a point where ice can maintain it. During the first part of the journey a great deal of the fruit is not cooled to any considerable extent, permitting the germination and growth under very favorable moisture conditions of blue-mold and other decay organisms. If these fungi start growth and development during the first part of the journey, while the temperatures in most portions of the car are relatively high, the lowest temperatures that can be maintained in an iced car will not entirely retard further growth and development.

PRECOOLING.

Precooling is the term employed to designate the quick and prompt cooling of fruits, vegetables, and other produce prior to shipment. The primary object of precooling is obviously the delivery of perishable produce at the markets in a fresher, sounder, and more wholesome condition than is possible under either ventilation or ordinary refrigeration. If precooling properly done fails in this respect or does not bring increased returns commensurate with the extra expense involved, it is not justifiable from a commercial or any other standpoint.

As already pointed out, under ordinary refrigeration the rate of cooling is exceedingly slow, the ice being required not only to take the heat out of the fruit but also to take up the heat leakage through the car walls. On the other hand, if the fruit is thoroughly cooled before shipment, the ice has only to maintain low temperatures against the leakage of warmer air through the car. One of the main objects of the prompt cooling of citrus fruits in the Gulf States is to prevent the germination of blue-mold spores and to retard or arrest the development of stem-end decay. While blue mold will continue to grow and develop at temperatures even as low as freezing, spore germination takes place but slowly at 40° F. The stem-end decay fungus grows and develops but slowly at temperatures below 40°, and it is not very active at temperatures between 40° and 50° F. The beneficial effects, therefore, of precooling citrus fruits as regards decay in transit and on the market result from the provision and maintenance of low temperatures unfavorable to any but slow germination of fungous spores and to the growth of fungi such as cause blue mold and stem-end decay.

Precooling, like refrigeration, should not be depended upon to overcome the injurious effects of rough and careless handling. However, during the citrus shipping season there oftentimes occur periods of extremely rainy, warm, and unfavorable weather when fruits are not only unusually tender but when practically every injury results in decay. The problem of commercially handling citrus fruits

so as to preserve the skin of the fruit in a sound, unbroken condition is, to say the least, under such conditions most difficult. Where the trees are thorny and full of dead wood, some injury is bound to occur, either through high winds before picking, or in placing the ladders, or in removing the fruit from the tree. It is during warm, moist periods that stem-end decay is frequently most severe. Refrigeration in transit is employed, more especially when fruit has been handled under unfavorable weather conditions, to retard the growth and development of the fungous organisms causing decay. While the decay on arrival has been somewhat lessened through the use of refrigeration, the rapid development of decay after the arrival of the fruit on the market makes refrigeration sometimes of doubtful value.

It is during such unfavorable weather conditions, when high decay occurs in a great many shipments, and during the warmer weather toward the end of the shipping season that precooling should be of greatest value.

Precooling citrus fruits in the Gulf States had not been attempted either experimentally or commercially prior to the season of 1913–14, although it has had considerable commercial application in the citrus and deciduous fruit districts of California for a number of years. During the last two seasons the Department of Agriculture has conducted extensive and careful investigations of the relationship of precooling to the decay of Florida oranges in transit and on the market. The results of these investigations and the results obtained in commercial plants erected prior to the opening of the 1914–15 season indicate that precooling is a valuable aid to careful and proper handling in insuring sound condition on arrival and for a period of about 10 days after arrival at the market. Proper handling with precooling may be the means of insuring the delivery of sound oranges throughout the whole shipping season. One of the most difficult problems heretofore has been that of uniformly placing the fruit on the market in good, sound condition and the establishing of a reputation for dependable keeping quality throughout the season. Both the investigational and commercial results indicate that precooling has peculiar application in the transportation of citrus fruits, especially oranges, from the Gulf States, particularly in view of the fact that during the greater part of the season precooled shipments can be forwarded with initial icing only. During about three months in the winter the maintenance of low temperatures in transit is entirely practicable by thorough precooling, even without initial icing or icing en route. Even where initial icing is used in the transportation of precooled shipments the combined cost of precooling and initial icing is considerably below the average cost of full refrigeration.

In general, tnere are two ways of doing precooling, the car or the warehouse method. In car precooling the fruit is first loaded into a refrigerator car ready for shipment, after which cold air is circulated through the load, forced in either through the ice bunkers or through the car door. In the warehouse method the fruit is first cooled in the warehouse cooling rooms before being loaded into the car for shipment. Where the precooling is done after the cars are loaded, cooling can not be commenced until the car is fully loaded and transported to the precooling plant. This necessarily involves some delay before cooling, such delay, if considerable, corresponding in a way to the delayed cooling of fruit under ordinary refrigeration. In the warehouse type of plant the fruit can be placed in the cooling rooms as soon as it is packed, and the cooling accomplished with less delay. As a rule, the cooling is more uniform in a warehouse plant and less refrigeration is required than in car precooling, as there is less leakage through the walls of the storage house than in the case of an ordinary refrigerator car. The refrigeration in a warehouse can be secured either by the use of an ammonia plant or from a mixture of ice and salt. For small associations, especially where ice can be obtained at a reasonable price, ice and salt plants are both practical and probably more economical than the more expensive ammonia plants. In this system, refrigeration is secured by drawing the air through the bottom of an insulated tank filled with a mixture of ice and salt. The temperature of the air after it has passed through this mixture will depend upon the percentage of salt mixed with the ice. Air is forced through a false floor in the cooling room up through and between the boxes of fruit and is again taken back to the ice tanks through ducts in the ceiling of the cooling room. This type of plant is, as far as equipment is concerned, very inexpensive and is especially applicable to sections where the shipping season is relatively short and where the output is not large enough to justify a larger and more expensive ammonia plant. No engineer is required for its operation, as any man with ordinary common sense can operate it efficiently.

Whatever method of precooling is used, it is essential that the fruit be cooled as promptly as possible after removal from the tree and that the cooling be thorough. Any considerable delay in cooling or failure to cool thoroughly may nullify any benefit that would result if the precooling had been done promptly and thoroughly.

COLD STORAGE.

Neither oranges nor grapefruit are held in cold storage to any extent in the producing districts prior to shipment to the markets. Limited quantities of both oranges and grapefruit are, however, frequently placed in cold storage at the market end. The success with which sound fruit can be held in storage depends primarily on two factors, the

length of the time in storage and the temperature at which it is held. Oranges, grapefruit, and lemons should be stored at temperatures considerably above 32° F.; oranges at 38° to 40°, lemons at about 42°, and grapefruit at 45° to 50°. Even at these temperatures the period of successful storage is comparatively short, not usually exceeding two months and frequently not more than a month or six weeks. Oranges take on a sort of brown stain in storage, in addition to being just as susceptible to serious spotting due to attacks of Colletotrichum as are grapefruit and lemons. This spotting is much more severe at low temperatures, particularly 32° F. It almost invariably develops on oranges or grapefruit when held for any length of time at 32°, or even on fruit held at more favorable temperatures too long. Frequent inspection should be made of fruit in storage, in order that any showing signs of spotting may be immediately removed and disposed of.

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